SSEBop Evapotranspiration Products
(Version 4.0, October 2019)

Evapotranspiration (ET) is the combination of transpiration from vegetation and evaporation from soil and one of the important components in the water cycle. Actual ET (ETa) from remote sensing data is produced using the operational Simplified Surface Energy Balance (SSEBop) model (Senay et al., 2013) for the period 2000 to Present at 1-kilometer (km) spatial resolution. The operational Simplified Surface Energy Balance (SSEBop) approach created by Senay et al. (2013) is developed with an unique parameterization for operational applications using Moderate Resolution Imaging Spectroradiometer (MODIS) Land Surface Temperature (LST) data from the Land Processes Distributed Active Archive Center (LP DAAC) as the thermal input source. The LST product is called MOD11A2 Version 6 and provides an average 8-day per-pixel LST with a 1 km spatial resolution in a 1,200 by 1,200 km grid (https://lpdaac.usgs.gov/products/mod11a2v006/). The model uses pre-defined, seasonally dynamic, boundary conditions that are specific to each pixel for “hot/dry” and “cold/wet” reference points (Senay et al. 2018, Ji et al. 2019) to estimate the ET fraction (ETf). More details on the SSEBop model can be found in Senay et al. (2013) and Senay (2018).

ETa data and anomaly products (current vs. 2001 – 2015) are available at: https://earlywarning.usgs.gov/ssebop/modis/8-day.
The actual ET data unit is a total in millimeters (mm) per 8-day period. The associated color ramp (see Figure 1a.) is available for download as a .style file for ArcGIS and as .txt file with RGB color codes. The *SSEBop_symbology* folder includes instructions on how to add the color ramp in ArcMap and further suggestions on the data visualization.
ET Anomaly % is the ratio of ETa and the corresponding median ETa, expressed as a percent value and refer to the corresponding color ramp in Figure 1b. The color ramp, .txt file with RGB color codes, and colormap file (.clr) are available in the *SSEBop_symbology* folder.

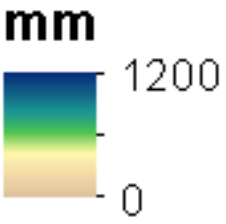

Figure 1a.

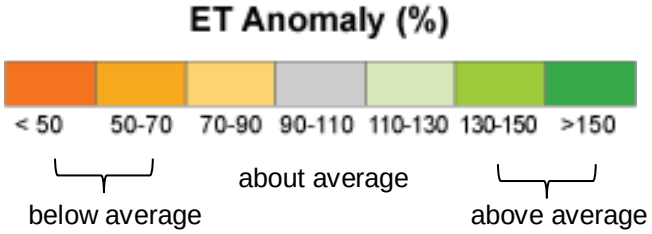

Figure 1b.

Listed below are all ET products offered:

Monthly ET products:
ET data products for each month are provided as .tif file in a zipped folder. The associated color ramp is available for download on the website.
ET anomaly products for each month are provided as graphics (.png and .pdf), as well as .tif file including the color ramp.

Yearly ET products:
ET data products for each year are provided as .tif files in a zipped folder. The associated color ramp is available for download on the website.
ET anomaly products for each year are provided as graphics (.png and .pdf), as well as .tif file including the color ramp.

Cumulative ET anomaly products:
Actual ET and anomaly data are available as cumulative products in intervals of 8-day periods and also grouped by major growing season:

- **April – October**

For display purposes, the season graphics begin on April 01 (Day-of-Year 091), but the data include the entire 8-day period (day 089 – 096) for both Actual ET and ET Anomaly. Additionally, an End of Season total ET raster (sum from Apr 01 – Oct 31) is available as .tif file in a zipped folder.

References:

Senay, G. B., S. Bohms, R. K. Singh, P. H. Gowda, N. M. Velpuri, H. Alemu, and J. P. Verdin. 2013. *Operational Evapotranspiration Mapping Using Remote Sensing and Weather Datasets: A New Parameterization for the SSEB Approach*. Journal of the American Water Resources Association 49 (3):577-591. https://doi.org/10.1111/jawr.12057

Senay, G. 2018. *Satellite Psychrometric Formulation of the Operational Simplified Surface Energy Balance (SSEBop) Model for Quantifying and Mapping Evapotranspiration*. Applied Engineering in Agriculture 34 (3):555-566. https://doi.org/10.13031/aea.12614

Senay, G. B., M. Schauer, N. M. Velpuri, R. K. Singh, S. Kagone, M. Friedrichs, M. E. Litvak, and K. R. Douglas-Mankin. 2019. *Long-term (1986–2015) crop water use characterization over the upper Rio Grande Basin of United States and Mexico using landsat-based evapotranspiration*. Remote Sensing 11 (13):1587. https://doi.org/10.3390/rs11131587

Ji, L., G. B. Senay, N. M. Velpuri, and S. Kagone. 2019. *Evaluating the Temperature Difference Parameter in the SSEBop Model with Satellite-Observed Land Surface Temperature Data*. Remote Sensing 11 (16):1947. https://doi.org/10.3390/rs11161947